Global Change NewsLetter

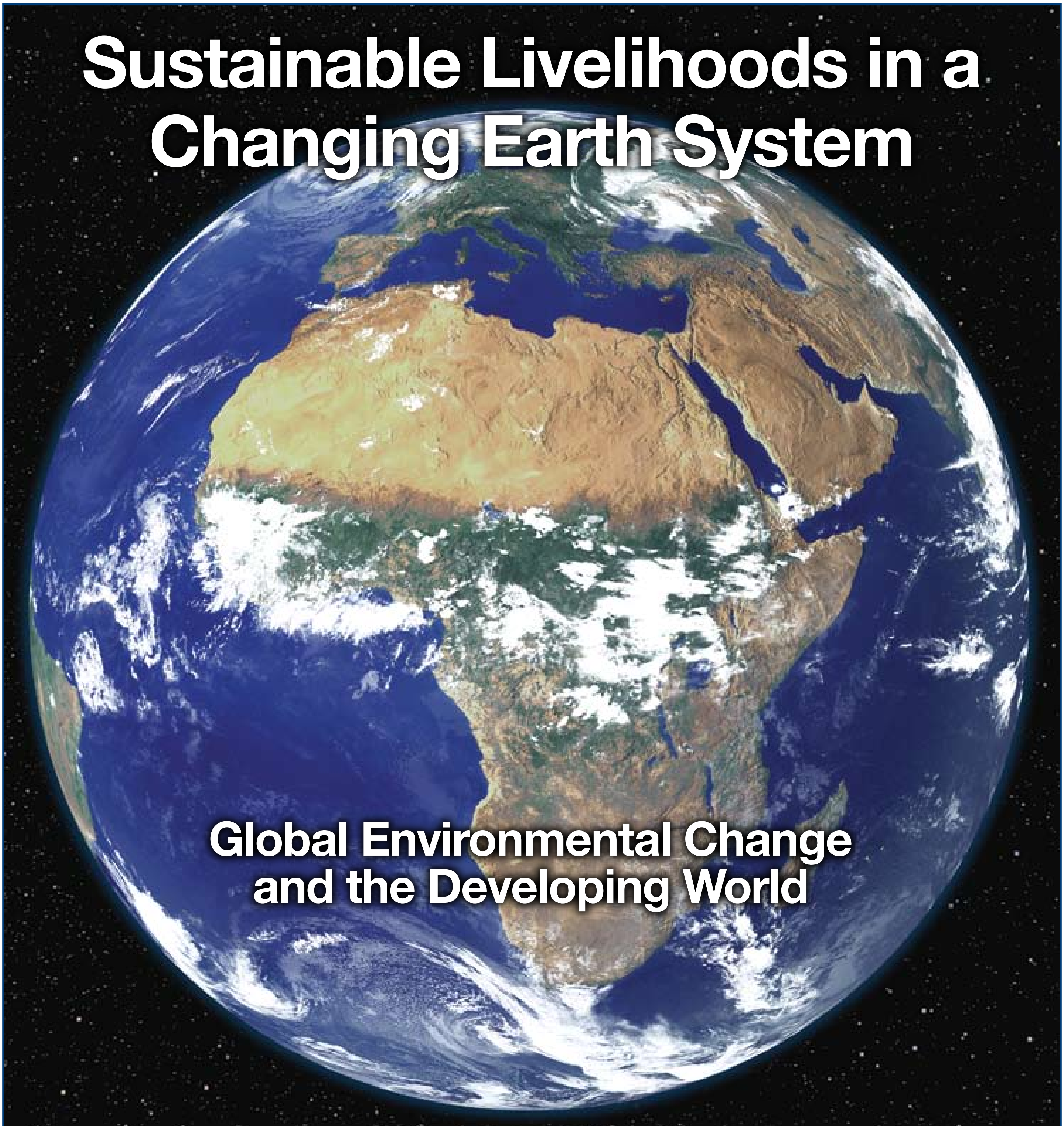
www.igbp.net

No. 71, May 2008

The Global Change NewsLetter is the quarterly newsletter of the International Geosphere-Biosphere Programme (IGBP).

IGBP is a programme of global change research, sponsored by the International Council for Science.

Sustainable Livelihoods in a Changing Earth System



Global Environmental Change and the Developing World

Sustainable Livelihoods in a Changing Earth System

IGBP's Congress in Cape Town, South Africa (7 to 9 May 2008) provides a timely focus on the effects—current and future—of global environmental change on developing countries in Africa and around the world. Last year's Intergovernmental Panel on Climate Change Fourth Assessment Report confirmed that "Africa is one of the most vulnerable continents to climate variability and change because of multiple stresses and low adaptive capability." A follow-on effect is the added difficulty many developing countries will face in achieving Millennium Development Goals while under pressure from changes in climate.

This issue of the Global Change NewsLetter profiles global research and modelling efforts by researchers in the IGBP network. Their work is aimed at assessing environmental changes and forming the basis for possible adaptation and mitigation strategies, on a global level but in particular for the developing world.

As a further outreach tool for the general public and policy makers, IGBP has produced a factsheet on global environmental change in Africa. Please see the newsletter centrefold for an easy-to-read, up-to-date guide to the major environmental challenges facing Africa, as well as a glossary of related Earth System Science terms and resource links for further information.

Mary Ann Williams
Science Communicator
IGBP Secretariet

Contents

Guest Editorial

Challenges in Africa due to Global Environmental Change

It is ironic that Africa, as the birthplace of humankind, seems particularly prone to environmental catastrophe in the modern world. The environmental and social challenges that face the world as a whole seem somehow distilled and focused in Africa, and yet it is often forgotten that this continent is the only one that has retained many of its terrestrial ecosystems in an almost intact form, despite substantial fragmentation and transformation of landscapes. This is exemplified, for example, by diverse megafauna, a component of biodiversity that has been decimated in other parts of the world, but which persists in Africa. African people and African ecosystems thus embody the concepts of vulnerability and resilience in a way that is not as clearly evident in other parts of the world.

The diversity of people, landscapes, ecosystems, material resources and social and political histories makes it impossible to come to brief conclusions about the threats and opportunities posed by ongoing and future global environmental change on the African continent. The threats themselves are diverse, while the opportunities are often hard to see. Composite threats of anthropogenic climate change, alien invasive species, land-use change and over-exploitation of natural resources, and human social trends can be seen as a lethal cocktail that threatens ecosystems, and in turn the very people who depend on the services they provide. A more optimistic view is that the inherent resilience of African ecosystems provides hope for sustainable development pathways into the future.

Climate change is currently enjoying particular attention as the primary environmental threat of the 21st century. Science suggests that its effects are at a scale that adds urgency not only to the efforts to prevent additional change, but equally important, to efforts to adapt to the impacts already occurring. This is particularly true for Africa, recognizing that additional climate impacts will result even if emissions of greenhouse gases are halted immediately. Indications are that the projected temperature increases for southern Africa (2020-2029) are between 1.5 to 2ºC, and may result in between 75-250 million people in Africa exposed to increased water stress. Some countries, for example, may face a reduction in crop yields of as much as 50% by as early as 2020. These threats face a continent experiencing significant socio-economic challenges today – the ten poorest nations in the world are in tropical and sub-tropical Africa.

Several African ecosystems are also at risk, with such unique systems as the Okavango Delta, Cape Fynbos and the Succulent Karoo emerging as prime candidates for significant biodiversity loss. For example, a recent scientific study exploring climate change impacts on sub-Saharan African plant species [1] projects that climate change will induce species migration and in many cases lead to habitat reduction. The authors examined over 5000 African plant species and show that 81-97% of the plant species' suitable habitats may decrease in size or shift due to climate change. By 2085 between 25-42% of the species' habitats are projected to be lost altogether. While these models are only a preliminary step in assessing climate change impacts to sub-Saharan African plant diversity, they provide an indication of the vulnerability of African biota to climate change. Ecosystem services that flow from these extend beyond the economic benefits of nature-based tourism, to include fundamental services such as indigenous foods, locally used plant-based medicines and even biomass production. In sub-Saharan Africa, for example, it has been estimated that over 80 percent of the population depends on traditional biomass for cooking.

On the other hand, we know very little about how the "fertilizing" effects of rising atmospheric CO_2 might ameliorate these climate impacts, and possibly affect the structure and function of African ecosystems. The iconic African biome – savanna – exists due to a dynamic balance of trees and grasses, mediated by fire and grazing amongst other drivers. It has been suggested that rising CO_2 levels could change this balance, but few data are available for Africa to test this idea, and no experimental program is addressing this question under natural field conditions. The implications of such changes are substantial for the sustainable use by people of savanna landscapes and their indigenous biodiversity.

Increasing mechanically-driven destruction of ecosystems is very evident in parts of Africa, though incomplete infrastructure slows the pace of this change, especially in much of central Africa. Likewise, limited sources of high levels of pollution pose problems only in certain transcribed regions. The use of fire by humans dates back millennia, and this change does not possess the extreme ecosystem-transforming potential that it does in other parts of the world. The invasion of ecosystems by rapidly expanding populations of alien species from other continents has emerged over the past few decades as one of the most significant threats to global biodiversity, and to the livelihoods of many people. Happily, there is some evidence to suggest that many ecosystems and trophic levels are resilient to this threat in Africa, though there are significant exceptions, and poor documentation may mask deeper threats.

Taken together then, African societies on the whole face extreme social challenges due to disease and poverty, while the resilience of their ecosystems continues to allow provision of goods and services except under the most dire of circumstances. Anthropogenic climate change threatens to undermine some of this resilience, and is a topic that requires clearer assessments to reveal its potential impacts. But it is ultimately the human dimensions of climate and compound global change trends that must be the focus in order to usefully reveal societal vulnerabilities in Africa for the short and medium term.

Guy Midgley is Chief Specialist Scientist, Global Change and Biodiversity Program, with the South African National Biodiversity Institute. He also chaired the IGBP Congress' Local Organising Committee.

Mary Scholes is a professor with the Department of Animal, Plant and Environmental Sciences, University of the Witwatersrand, South Africa, and a former member of the IGBP Scientific Committee.

Guy Midgley
email: midgley@sanbi.org

Mary Scholes
email: mary.scholes@wits.ac.za

References

1. McClean, C *et al.*, 2005 African Plant Diversity and Climate Change. Annals of the Missouri Botanical Garden. 92:139-152.

Air Pollution In South America: A Global Change Driver and a Global Connector

L. Gallardo

Air pollution is a daily, and often visible, experience for a large fraction of the South American population. Today roughly 83% of South Americans live in urban areas, compared to only 43% in 1950. Typically, the major urban centers accumulate wealth but also environmental problems, which poses for South Americans a distinct vulnerability in a changing climate. The deteriorating air quality in South American mega-cities has received increasing attention from local decision makers, scientists and the general public. Until recently though, these efforts have been largely decoupled from international efforts. This article provides a brief presentation of an on-going initiative on South American mega-cities and climate that will help establish the required global connection.

Addressing Emissions, Air Quality And Climate Scenarios In South America

The Inter American Institute for Global Change Research (IAI) has provided the means for the establishment of the South American Emissions Mega-cities and Climate (SAEMC) project, which is a Collaboration Research Network for the period 2006-2010, involving 23 researchers in Argentina, Brazil, Chile, Colombia, United States of America and, most recently, Peru. In addition to this, IAI has approved a two-year project (2007-2009), Adaptation to health impacts of air pollution and climate extremes in Latin American cities (ADAPTE), providing a stronger human dimension value to the original project. These projects represent an unprecedented opportunity for strengthening and coordinating regional research capabilities, connecting regional and global efforts, and providing sound scientific basis for sustainable policies.

The SAEMC project works in five areas:

Emissions: SAEMC has carried out several up-to-date measurement campaigns intended to characterize vehicular emissions in Santiago, Bogotá, São Paulo and Buenos Aires. Also, SAEMC has completed an evaluation of the emission inventory for carbon monoxide in Santiago, corroborating the total numbers but introducing substantial changes in the diurnal cycle of emissions in some areas of the city. In addition, there is ongoing work around the reconciliation between global and local inventories.

Chemical Climate Scenarios: We will use the multiple grid nesting approach of the Coupled Chemistry Aerosol and Tracer Transport model with the Brazilian developments on the Regional Atmospheric Modeling System (C-CATT-BRAMS), to provide high-resolution physical and chemical climate scenarios over South American cities.

Chemical Weather Forecasting: Brazil is the leader in atmospheric research in South America. The National Institute for Space Research (INPE/CPTEC) houses the largest weather forecasting center in the region, and has operational tools for chemical weather forecasting. A pilot within the SAEMC activity is focusing on the connection between INPE/CPTEC and the Chilean Meteorological Office (Dirección Meteorológica de Chile, DMC). A dedicated group of senior meteorologists has been created at DMC, and they have so far implemented several chemical weather forecasting tools. SAEMC considers the involvement of DMC in this project from its very inception a major success. In the immediate future SAEMC hopes to add the Peruvian Meteorological and Hydrological Service (SENAMHI) to this network as well. A similar test-bed has been initiated for Buenos Aires.

Future Plans for Characterisation of Aerosols: South America local authorities have invested considerable resources in urban air quality monitoring, focussing on exposure to so-called criteria pollutants (Table 1). However, aerosol measurements in the region, except for some areas of Brazil, are still sparse and usually limited to concentration levels of partially (PM10) and completely (PM2.5) inhalable particles. A more detailed characterisation of aerosol size distribution and

City	Current number of stations	Pollutant measured	Begining of measurements	Note
Bogotá	15	NO, NO_2, SO_2, TSP, PM10, PM2.5, O_3, CO, CH_4, HCHO, NMHC, benzene, toluene	1997	Data available at: www.dama.gov.co (automatic network) Not all the stations measure all pollutants
Buenos Aires	3	1 station: CO, NO, NO_2 1 station: CO, NO, NO_2, TSP, PM10, PM2.5 1 station: NO, NO_2, CO, benzene, toluene, and xilenes	1986 2005 2007	Responsible: City government
Lima	5	TSP, Dust fall, PM10, PM2.5 CO, SO_2, NO_2, O_3	Dust fall: since 1990 TSP, since 1987 PM10 and PM2.5, 2000 to date CO, SO_2, NOx, O_3, 2001 to date	Data available online: http://www.digesa.minsa.gob.pe/aire_LC_01.htm Majority of the data covers 2002 to date
Medellín	17	TSP, PM10, O_3, NO_2, SO_2, HC, CO, PM2.5	1993	Data available online: www.metropol.gov.co from April 2008
Santiago	8	CO, SO_2, NO_2, O_3, HC, PM10, PM2.5	1988	Data available online: http://www.seremisaludrm.cl/sitio/pag/aire/indexjs3aire.asp. Majority of the data covers 1997 to date
São Paulo	30	CO, SO_2, NOx, O_3, PM10, PM2.5	1981 (automatic stations) 1973 (manual stations for SO_2 and smoke)	Data available online: www.cetesb.sp.gov.br PM2.5 measured since 1999

Table 1. Available air quality monitoring in South American cities participating in SAEMC. Notice that not all stations measure all pollutants.

chemical composition is at best sporadic. SAEMC's work in this area involves compiling available information and making comparative evaluations. Also, SAEMC will analyse the aerosol content and size distribution for mass and number of major and minor trace elements and some organic compounds for at least three mega-cities. In the case of São Paulo, these observational aspects are complemented by a modelling study focusing on the urban aerosol plume and its interactions with clouds.

Grid Computing: As part of the SAEMC project development, an Information and Technology (IT) research group has emerged. In addition to maintaining the project's webpage (http://saemc.cmm.uchile.cl/) and facilitating the operation of sophisticated models and platforms, the IT group has optimized the use of available computer facilities, making it possible to interconnect various systems (grid computing). South America already has fast internet connections covering all countries except Bolivia and Paraguay. However, this infrastructure is – to the best of our knowledge – largely under-exploited, with less than 10% of the bandwidth currently being used. As a feasibility test, SAEMC is connecting cluster systems at CPTEC in Brazil, and at the Center for Mathematical Modelling and the Chilean Meteorological Office in Chile. Despite the obvious gains and advantages of improving the use of resources and sharing scarce, very specialized expertise, cultural and political barriers among and also within South American countries and institutions slow progress on such efforts. The existence of an organising body such as SAEMC helps overcome some of these obstacles.

International Linkages

Material and human resources for atmospheric research in South America on

Figure 1. South American cities analyzed in the project (with 2005 populations in parentheses): Medellín (3 million), Santiago (6 million), Bogotá (7 million), Lima (8 million), Buenos Aires (13 million), and São Paulo (18 million).

a country-by-country basis are far too small to allow a significant contribution to international programs and to produce sustained impacts in the local development. One notable exception is Brazil, where the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) has provided first-world infrastructure and an unprecedented increase in human resources. Thus, international linkage among South American countries is absolutely critical. Further, it is essential that a significant fraction of our resources is dedicated to capacity building at various levels, including technical, professional and graduate training. Therefore, both SAEMC and ADAPTE put roughly 70% of their resources into fellowships for professional exams and graduate theses. In addition to this, we facilitate short- and long-term exchanges of students and researchers, abilities and knowledge sharing and, when possible, post-graduate programs.

Summary and Outlook

SAEMC will provide regional scale past, present and future climate change scenarios, with a unique emphasis on the evolution of air quality in South American mega-cities, where more than 80% of the population of the continent lives. Such high resolution scenarios are not currently available for this area of the world. Comparable estimation and evaluation methodologies as well as reconciled local, regional and global scale emission inventories are being produced for South America. To date, this region has been poorly studied in this respect despite its potential vulnerability to global change and its effects, particularly in mega-cities. A coordinated regional chemical weather forecasting system is being deployed, allowing human and hardware resource sharing, and making use of currently under-exploited fast internet connections.

Through this project, a well-established and enhanced research network, particularly in terms of educated human resources, will be able to better contribute to and lead global change research in the Americas within the framework of Earth System Science. The resulting unique and new databases will assist various other relevant research issues and assessments, such as for human health, ecology, water and energy resources, economics and city planning.

All in all, we see this network as a sound – and in many aspects unprecedented – basis for developing Earth System Science in South America around the pressing challenges of urbanization, air quality deterioration and climate change.

Laura Gallardo*

Departamento de Geofisica
& Centro de Modelamiento Matemático,
Universidad de Chile,
Santiago, CHILE,
lgallard@dim.uchile.cl

**PI for the South American Emissions Mega-cities and Climate project (IAI CRN 2017)*

Acknowledgment

This work was carried out thanks to contributions from SAEMC and ADAPTE researchers and students and with the aid of a grant from the Inter-American Institute for Global Change Research (IAI) CRN II 2017 which is supported by the US National Science Foundation (Grant GEO-0452325). The author thanks the contributions from all co-PI and students participating in SAEMC.

Links

Brazil National Institute for Space Research (INPE/CPTEC) http://meioambiente.cptec.inpe.br/

Chilean Meteorological Office (Dirección Meteorológica de Chile, DMC) http://www.meteochile.cl/

Coupled Chemistry Aerosol and Tracer Transport model with the Brazilian developments on the Regional Atmospheric Modeling System (C-CATT-BRAMS), http://meioambiente.cptec.inpe.br/modelo_cattbrams.html

Inter American Institute for Global Change Research (IAI), http://www.iai.int

Peruvian Meteorological and Hydrological Service (SENAMHI), http://www.senamhi.gob.pe/

South American Emissions Mega-cities and Climate (SAEMC), http://saemc.cmm.uchile.cl

A Scientific and Technological Revolution for the Amazon

C. Nobre, M. Lahsen and J. Ometto

The conclusion is inescapable: The economic model underpinning present rural development in the Brazilian Amazon is outdated. Based on the replacement of forests by agriculture and cattle ranching, it is both economically inefficient and highly destructive to the environment. Over 750,000 square kilometres of the Brazilian Amazon have already been deforested, and additional area of equal size is in a process of accelerated degradation. While an area of about 10,000 to 25,000 square kilometres is being deforested every year in the Brazilian Amazon, agricultural products from the deforested area and from timber exploitation represent less than 0.5% of the Brazilian GNP. Fifty years of deforestation have not resulted in wealth or better quality of life for most Brazilians, including those living in the Amazon. Considering these facts, in addition to the Amazon region's important role in regulating global climate, it is clear that deforestation needs to be halted, and fast.

Unfortunately, present economic trends conspire against the Amazon, placing a high premium on agricultural commodities such as soybeans and meat, and encouraging short-sighted practices, which cause long-term, irreversible environmental damage. Biofuels potentially could become an additional, grave threat to the region, and represent a continuation of the traditional model of ever-increasing deforestation and degradation of biodiversity-rich tropical forests and savannas in the region.

Part of the challenge is to reconcile renewable energy production and natural resource preservation with the maintenance of traditional agricultural activities, rendering the latter more efficient and inventing new ways of benefiting from the region's natural resources in ways that meet broad-based local needs. This requires a heightened sensitivity to local social realities and the negative impacts of economic inequality and globalization, as findings suggest that cultural diversity (especially, but not exclusively, indigenous knowledge) and biological diversity are interdependent; the former tends to enrich the latter.

The challenge to change the regional developmental model is largely political in nature. Nevertheless, the successful development of a regional economic model based on the use and preservation of biological resources also depends on science and technology. Indeed, a scientific and technological revolution should be a central, strategic priority for the region. Science and technology must be mobilized to meet the pressing necessity of new knowledge to fully develop new productive chains based on smart use of biodiversity, to find ways of valorising environmental services provided by ecosystems, and to identify ways of reconciling local benefits and quality of life with economic activities in the region.

In general, the most tangible benefits of science and technology do not derive directly from new knowledge creation but from the translation of already existing knowledge into goods, services and practices. The Amazon may be an exception. The paradigm of intense application of existing knowledge does not apply to sustainable development of this region inasmuch as the existing and, in fact, practiced knowledge and model of rural agricultural development has proven to be inappropriate for the humid tropics because of the high social and environmental costs incurred. The fact that there is no fully developed and industrialized tropical country means that there is no obvious model to emulate. A lot will have to be discovered and translated into practical social, economic and environmental benefits.

Benefits also depend centrally on the creation and retention of a workforce capable of understanding and applying existing knowledge. Technological capacity building has proven fundamental to the strengthening economies of developing countries, including China, India and Brazil. Over the past 50 years, Brazil has managed to create islands of excellence in science and technology similar to those of developed countries. However, historical regional inequalities, especially those in education, severely limit the use of science and technology for economic and social development of the poorer, less favoured regions of the developing world, including the Amazon and the Brazilian Northeast. Poverty is almost always associated with environmental degradation

Four Steps of Progressive Forest Degradation in the Amazon

T1 – Selective Logging

T2 – Loss of under-canopy

T3 – Loss of canopy >50%

T4 – Loss of canopy >90%

Source: Instituto Nacional de Pesquisas Espaciais – INPE, 2008 which, in a vicious circle, affects the income and quality of life of the poorer parts of the population, in addition to undermining health conditions and capacity to adapt to environmental changes.

In practical terms, the necessary scientific and technological revolution for the Amazon needs to create favourable conditions for "adding value to the heart of the forest", in geographer Bertha Becker's words. This requires the development of an innovative economy, based on the forest and its aquatic resources, with the economic valorisation of its biodiversity. This will also require mechanisms to facilitate market knowledge, market access, product quality controls, and conformity with international standards bearing on product marketability. Nowadays, very few productive chains based on the Amazon's natural products reach the global markets, and fewer yet benefit non-elite, local populations at the place of their extraction. In the meantime, more and more products from outside regions are being used within the Amazon region to replace traditional products. This trend can be reversed. It is very feasible to develop from 50 to 100 productive chains based on biodiversity capable of reaching global markets, thereby generating, within 10 to 20 years, a new forest-and-aquatic resource-based economy with intensive economic use of the biodiversity, and strong local value aggregation via industrialization. This new economy has the potential to become much larger than the present one which is based on the replacement or destructive exploitation of the forest.

This diagnosis is long-standing, and begs the question: why has such a new, alternative economic reality not yet begun to develop, despite an ever-intensifying national desire to interrupt the present state of development based on deforestation? How can we meet national desires to reconcile environmental preservation and sustainable, broadly beneficial economic development in the Amazon? Answers require broad-based discussion and inventiveness, including a new vision of science and technology. Among other general conditions discussed above, including the improvement of basic education, it is essential to create a network of new institutions for higher learning, basic research, and advanced technology development, with a specific focus on both forest and aquatic resources. These institutions should be created so as to radically decentralize science and technology throughout the vast Amazon, maximizing the participation, diversity and potential of sub-regions. The network should include five or six new technological institutions, each with 500 to 600 faculty, researchers, engineers and technicians, multiplying the number of active researchers in the Amazon three- or four-fold. Cutting-edge technology would make it possible for some institutions to develop sophisticated research on biotechnology and nanosciences applied to "biomimicry"[1]. Connected to a network of associated laboratories reaching every part of the Amazon and interconnected by cutting-edge information technology, these institutions would serve as regional poles of the new technological development model, much as the Aeronautics Institute of Technology (Instituto Tecnológico de Aeronáutica - ITA) in the State of São Paulo did in the 1950s to 1970s for the rapid development of the now world-important Brazilian aircraft industry. What the Amazon needs is many such technological institutes, to envision, facilitate, analyze and implement innovative industrial models for the region. These institutes should be involved with the development and value aggregation in the entire productive chain of dozens of products from the Amazon, from bio-prospecting and product development to commercialization and global marketing. Although an apparently simplistic recipe for regional development, no tropical country has ever adopted anything along these lines on a large scale.

Carlos Nobre
Centro de Previsao de Tempo e Estudos Climaticos (CPTEC)
Instituto Nacional de Pesquisas Espaciais (INPE)
IGBP Regional Support Office in Brazil
Av. dos Astronautas, 1.758 - Jd. Granja São José dos Campos, SP 12227-010, BRAZIL
email: carlos.nobre@inpe.br

Myanna Lahsen
IGBP Regional Support Office in Brazil
email: myanna@igbp.inpe.br

Jean Ometto
IGBP Regional Support Office in Brazil
email: jpometto@igbp.inpe.br

References

1. Biomimicry can be defined as the study of how complex biological systems find answers, on a nano-molecular scale, to be reproduced in practical applications. It is a new scientific area still to be explored for tropical ecosystems.

Global Environmental Change and Food Security

P. Ericksen

Food security, defined as when *all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996)*, is a policy issue of importance in just about every country. Increases in the efficiency and productivity of food systems have resulted in successes around the world in reducing the prevalence of hunger and improving nutrition. However, these successes are shadowed by serious concerns about those aspects of food systems that pose threats to social, economic and environmental goals and hence undermine food security. Food security for many people, particularly those in the poorer parts of Africa, Asia and Latin America, remains a difficult goal to achieve, due to a combination of social, economic and environmental stressors. Future global environmental change such as increased climatic variability, land degradation, and loss of biodiversity, in the context of social, political and economic changes, may bring unprecedented stresses to bear on food systems and food security.

To fully understand the impacts of global environmental change on food security, it is important to focus on food systems, not just agricultural production, because climate change affects food security through multiple paths, not just through the direct effects of climate change on crop yields, for example. Adaptation may occur at several points in food systems, not just at the place of production. Analysts of food security and food systems recognize that agriculture and food provisioning are only one component of food systems, and that food availability from production is only one dimension of food security [1].

Environmental change will affect not only food production but also livelihoods and

-continued on page 15

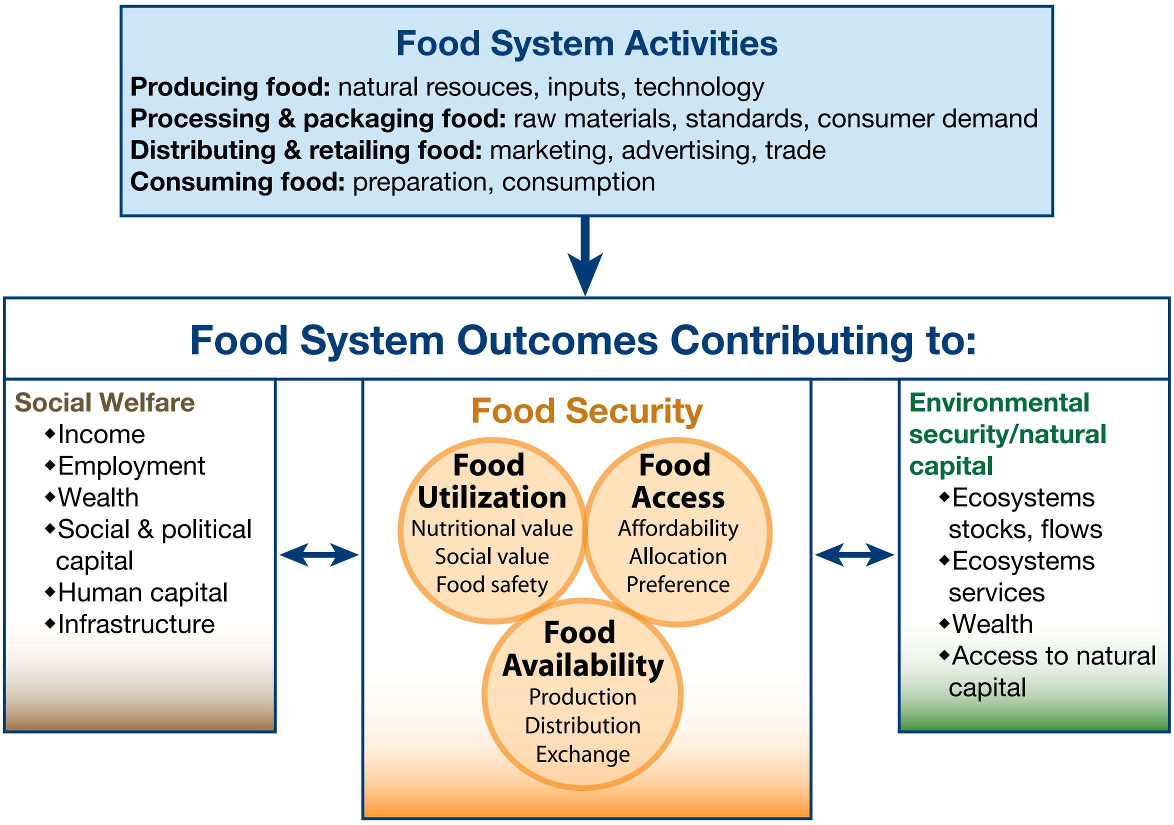


Figure 1: Components of food systems. (Ericksen, 2008)

Global Environmental Change and Africa

Two recent high-level reports (the IPCC 4th Assessment Report and the Stern Review) have stressed that developing countries are particularly vulnerable to projected future climate changes. The IPCC described Africa as likely to be the most vulnerable continent. This factsheet outlines Africa's current environmental conditions, highlights environmental and livelihood issues at high risk to environmental change, and briefly outlines IGBP's efforts in the region.

Africa is characterised by its diversity of peoples and natural environments. The continent and its adjacent islands occupy a total land area of 30.4 million square kilometers, slightly more than 20% of the world's landmass. It had a population of over 880 million in 2005, with a growth rate of 2-4%, twice the global mean. Africa's population is projected to double in the next 22 years, even with AIDS reversing decades of gains in life expectancy. The growing population will exacerbate existing problems of food security and the provision of safe water, education and health services. It adds ecological stresses to the glaring economic strains evident in Africa.

Contemporary Africa is demonstrably vulnerable to both droughts and floods, with negative impacts on food production, human health, water resources, and degradation in dry lands and coastal zones. Africa's vulnerability is likely to increase in future, because the future is likely to be hotter, and large areas are projected to become drier and even more rainfall-variable than at present. In general, the adaptive capacity of local, national and regional institutions in Africa is relatively low due to limited economic, human, infrastructural, and information resources and governance and various types of conflicts that exacerbate the situation. Africa is particularly vulnerable to changes with a negative impact on food production, human health, water resources, and natural-resource-based livelihoods.

Four top-level issues are the focus of concern with respect to global environmental change and its impacts in Africa:

- Food and nutritional security, including crops, wild-gathered resources, livestock resources and freshwater and coastal fisheries;
- Water resources, particularly in the water-limited subhumid, semi-arid and arid regions, and especially in relation to groundwater;
- Health, especially in relation to the biodiversity-linked, environmentally-mediated and vector-borne diseases that are responsible for the majority of the high disease burden in Africa; and
- Ecosystem integrity, on which the persistence of biodiversity and the delivery of ecosystem services depends.

These focal issues relate closely to the United Nations' Millennium Development Goals. Indeed, the effects of global change on Africa will make achieving those goals—which range from the eradication of poverty to ensuring environmental sustainability—more difficult.

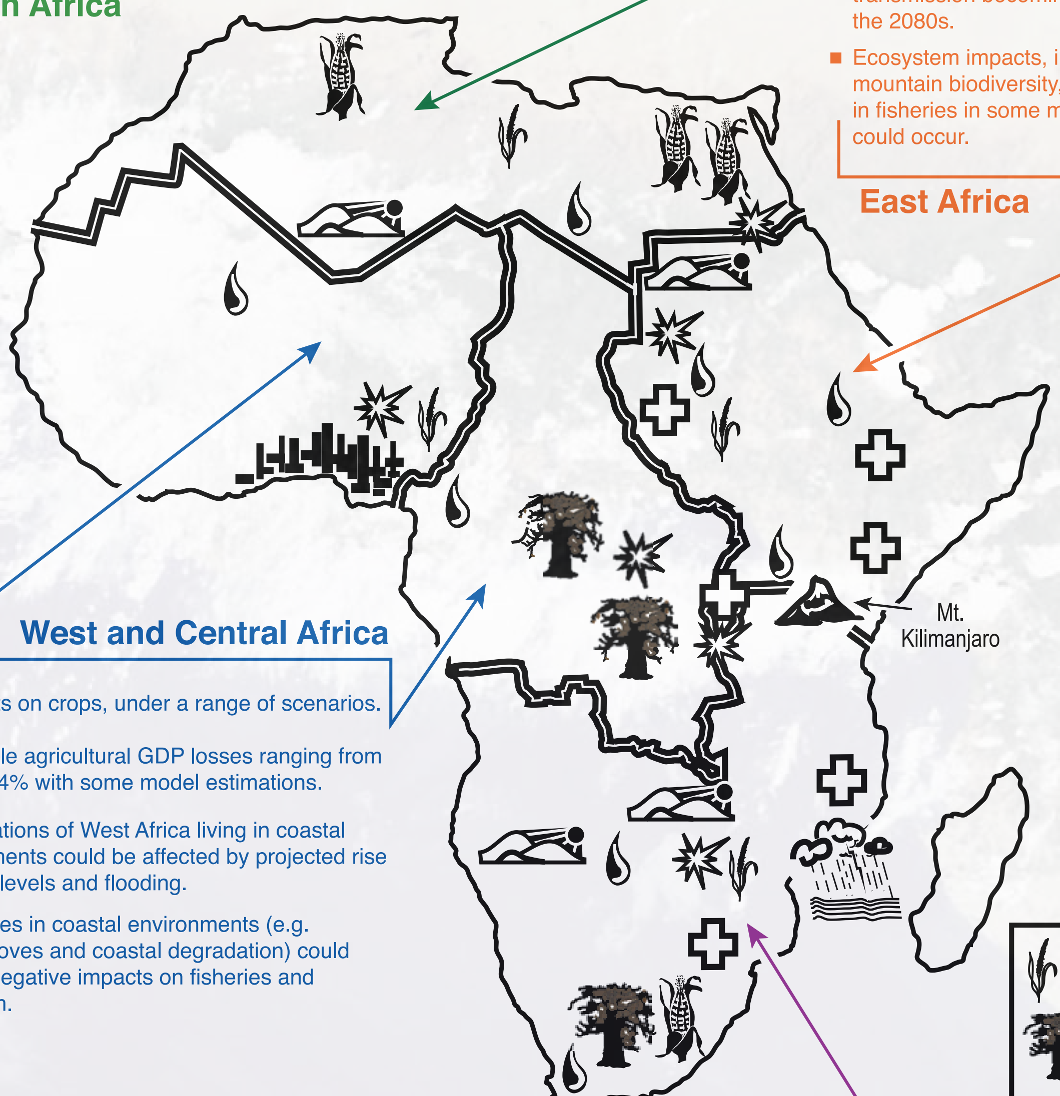
Examples of current and possible future impacts and vulnerabilities associated with climate variability and climate change for Africa

North Africa

- Climate change could decrease mixed rain-fed and semi-arid systems, particularly the length of the growing period, e.g. on the margins of the Sahel.
- Some assessments show increased water stress and possible runoff decreases in parts of North Africa by 2050. While climate change should be considered in any future negotiations to share Nile water, the role of water basin management is also key.

East Africa

- Rainfall is likely to increase in some parts of East Africa, according to some projections, resulting in various hydrological outcomes.
- Previously malaria-free highland areas in Ethiopia, Kenya, Rwanda and Burundi could experience modest changes to stable malaria by the 2050s, with conditions for transmission becoming highly suitable by the 2080s.
- Ecosystem impacts, including impacts on mountain biodiversity, could occur. Declines in fisheries in some major East African lakes could occur.

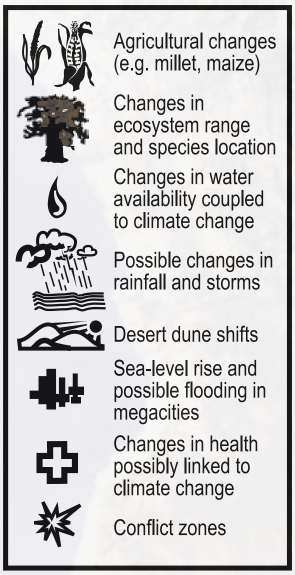


West and Central Africa

- Impacts on crops, under a range of scenarios.
- Possible agricultural GDP losses ranging from 2% to 4% with some model estimations.
- Populations of West Africa living in coastal settlements could be affected by projected rise in sea levels and flooding.
- Changes in coastal environments (e.g. mangroves and coastal degradation) could have negative impacts on fisheries and tourism.

Southern Africa

- Assessments of water availability, including water stress and water drainage, show that parts of southern Africa are highly vulnerable to climate variability and change. Possible heightened water stress in some river basins.
- Southward expansion of the transmission zone of malaria may likely occur.
- By 2099, dune fields may become highly dynamic, from northern South Africa to Angola and Zambia.
- Some biomes, for example the Fynbos and Succulent Karoo in southern Africa, are likely to be the most vulnerable ecosystems to projected climate changes, whilst the savanna is argued to be more resilient.
- Food security, already a humanitarian crisis in the region, is likely to be further aggravated by climate variability and change, aggravated by HIV/AIDs, poor governance and poor adaptation.



Note that these are indications of possible change and are based on models that currently have recognised limitations. For details and more information see the Foruth Assessment Report of the IPCC, chapter 9, Africa.

Scientists "Highly Confident" in Effects of Environmental Change on Africa

In its Fourth Assessment report, issued in 2007, the Intergovernmental Panel on Climate Change (IPCC) highlighted the following effects of global environmental change on Africa (with their levels of certainty in parentheses):

- Africa is one of the most vulnerable continents to climate change and climate variability, a situation aggravated by the interaction of 'multiple stresses', occurring at various levels, and low adaptive capacity (high confidence).
- African farmers have developed several adaptation options to cope with current climate variability, but such adaptations may not be sufficient for future changes of climate (high confidence).
- Agricultural production and food security (including access to food) in many African countries and regions are likely to be severely compromised by climate change and climate variability (high confidence). Projected reductions in yield in some countries could be as much as 50% by 2020, and crop net revenues could fall by as much as 90% by 2100, with small-scale farmers being the most affected. This would adversely affect food security in the continent.
- Climate change will aggravate the water stress currently faced by some countries, while some countries that currently do not experience water stress will become at risk of water stress (very high confidence). About 25% of Africa's population (about 200 million people) currently experience high water stress. The population at risk of increased water stress in Africa is projected to be between 75-250 million and 350-600 million people by the 2020s and 2050s, respectively.
- Changes in a variety of ecosystems are already being detected, particularly in southern African ecosystems, at a faster rate than anticipated (very high confidence).
- Climate variability and change could result in low-lying lands being inundated, with resultant impacts on coastal settlements (high confidence).
- Human health, already compromised by a range of factors, could be further negatively impacted by climate change and climate variability, e.g., malaria in southern Africa and the East African highlands (high confidence).

More Information

DIVERSITAS, an international programme of biodiversity science
www.diversitas-international.org/

Earth System Science Partnership (ESSP)
www.essp.org/

Intergovernmental Panel on Climate Change (IPCC)
www.ipcc.ch/

International Council for Science (ICSU)
www.icsu.org

International Geosphere-Biosphere Programme (IGBP)
www.igbp.net

International Human Dimensions Programme on Global Environmental Change (IHDP)
www.ihdp.uni-bonn.de

Millennium Ecosystem Assessment
www.maweb.org

United Nations Framework Convention on Climate Change (UNFCCC)
www.unfccc.int/

United Nations Millennium Development Goals
www.undp.org/mdg/

World Climate Research Programme (WCRP)
http://wcrp.wmo.int/

Glossary

Adaptive Capacity: The ability of a socio-ecological system to cope with new situations without losing options for the future.

Climate Variability: Refers to the variation in climate over time. It describes changes in the variability or average state of the atmosphere, or average weather, over short time scales usually a decade or less. These changes may come from processes internal to the Earth, be driven by external forces (e.g. variations in sunlight intensity) or, most recently, be caused by human activities.

Coupled Human-Environment System: A bounded, integrated unit comprised of human, ecosystem/biological, and environmental components. The coupled system reinforces analysis and assessment focused on the synergy and reciprocal relations among people, physical environment, and biota, emphasizing feedbacks between the human and natural subsystems. This approach contrasts with traditions of study that separate coupled systems into their components.

Earth System: The Earth System is the unified set of physical, chemical, biological and social components, processes and interactions that together determine the state and dynamics of Planet Earth, including its biodata and its human occupants. The interactions and feedbacks between the component parts are complex and exhibit multi-scale temporal and spatial variability. The understanding of the natural dynamics of the Earth System has advanced greatly in recent years and provides a sound basis for evaluating the effects and consequences of human-driven change.

Food Security: The state achieved when food systems operate such that ‘all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life’ (FAO, 1996). Food security is underpinned by food systems and is diminished when food systems are stressed. This stress can be caused by a range of factors in addition to GEC (e.g. conflict, changes in international trade agreements and policies, HIV/AIDS) and may be particularly severe when these factors act in combination (GECAFS, 2006).

Livelihood: A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.

Resilience: The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Sustainability: Sustainability refers to the development of systems capable of ensuring that future generations will have coupled human-environment systems capable of providing goods and services for the long-run, without degradation in structure or function.

GLOBAL IGBP CHANGE

The International Geosphere-Biosphere Programme
The Royal Swedish Academy of Sciences
Box 50005, Lilla Frescativägen 4
SE-104 05 Stockholm, Sweden
Tel: +46 8 16 64 48
Fax: +46 8 16 64 05
E-mail: info@igbp.kva.se
www.igbp.net

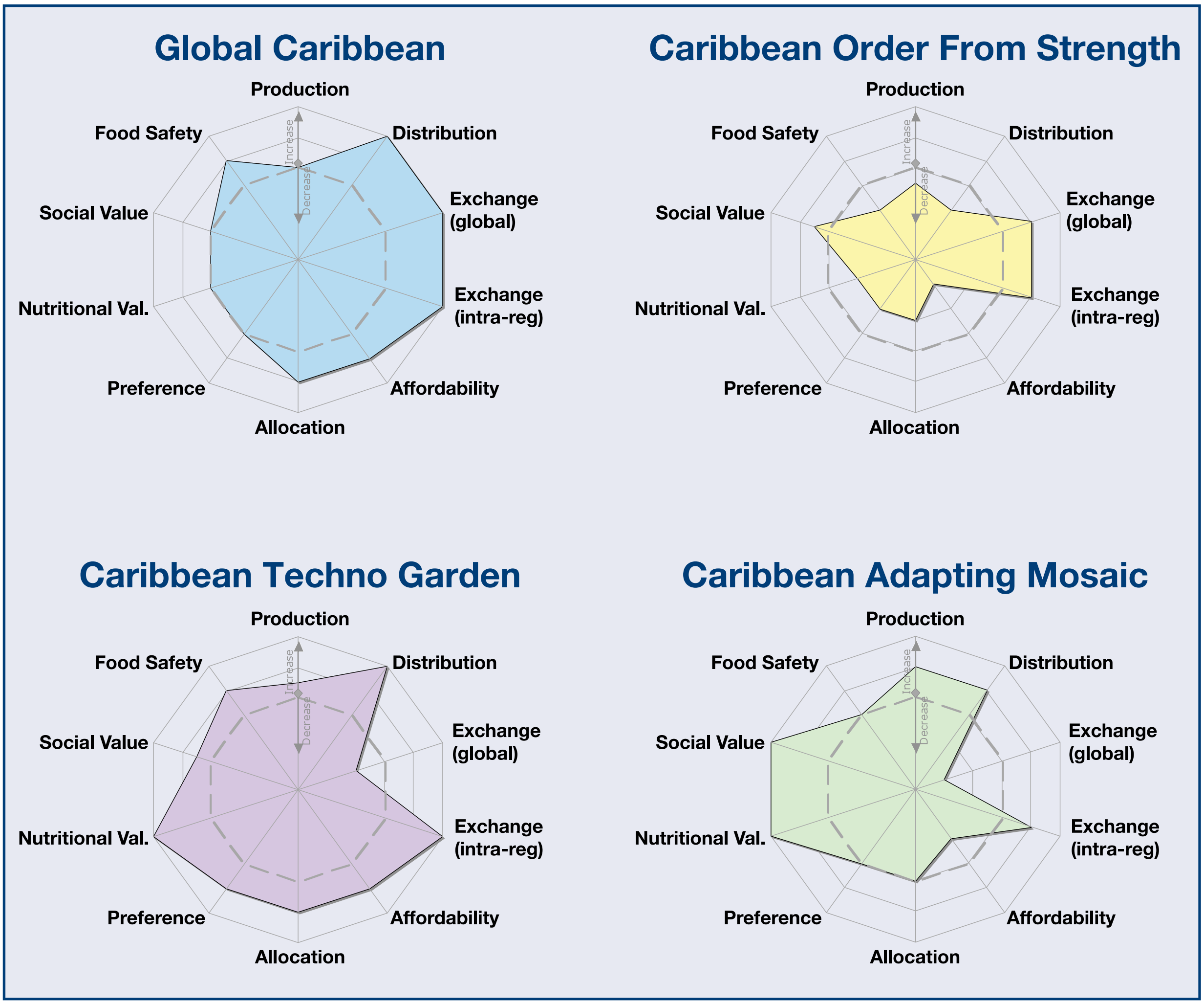


Figure 2: Food security outcomes under four different scenarios for the Caribbean [4].

-continued from page 10

economies. Millions of people are already hungry, especially in Africa. The recently released UNDP Human Development Report states that 17% of the world's population are malnourished, and this increases to 36% of people in sub-Saharan Africa. Many of these people are hungry not (only) because crops may have failed, but because they do not have access to land to produce crops or graze animals or to jobs that provide incomes adequate for buying food. In Asia and Africa more than half of the labour force work in agriculture and have livelihoods dependent on the success not only of production but also of markets for agricultural produce [2]. At a larger scale, many countries in the developing world derive more than 20% of their GDP from agriculture (India and Kenya for example) or are dependent on food aid for more than 5% of dietary consumption, especially for their poorest residents [3]. Natural disasters already provide important reminders of how extreme climates can devastate food systems – with floods such as those in Bangladesh and Mexico last year not only destroying harvests but also creating unemployment in agriculture and processing, damaging roads and other infrastructure essential for relief and trade, and spreading disease that intersects with food shortages to cause illness and death.

A food systems approach enables an analysis of how vulnerability of food systems to climate change arises as a function of social and environmental processes. Coping or adaptive capacity, which is largely determined by social, economic and institutional factors, varies greatly among households and communities. The approach used by the Global Environmental Change and Food Systems (GECAFS) programme helps to highlight whether or not there is sufficient adaptive capacity to buffer against a climatic stress at a variety of places in the food system (Figure 1). For example, GECAFS work in the Indo-Gangetic Plain shows how the nutritional value of food is influenced by climate variability and that adaptation is inhibited by the lack of extension services. It also demonstrates how drought affects agricultural incomes, causing migration in the search for off-farm incomes (GECAFS unpublished results). The framework can be used to identify a range of adaptation options to ensure food security in the face of climate change, and to assess whether these options will have positive or negative feedbacks to the earth system and food security.

A holistic approach to food system and global environmental change interactions also allows consideration of food system feedbacks on the environment. For example, the major environmental concerns related to food production are increased demands on water availability for irrigation [5], an increase in pollution from agricultural inputs and soil loss [6], and a large increase in the energy demands throughout the food production sectors [7]. Recent studies [8, 9] agree that land use modification for food production has significant and wide-spread impacts on ecosystem functioning. Much of this impact, including feedbacks, has been negative, e.g. biodiversity losses have been recorded from land conversion, and water availability and access have been heavily modified for agricultural use [9, 10]. However, most studies of the impact of global environmental change, particularly climate change, have only looked at the potential consequences for crop production [11]. The interactions of the other components of food systems with environmental change remain largely unexamined. As discussed above, food security outcomes are determined by many other factors besides production.

The key issue for many policy makers is how to choose between the inevitable tradeoffs in food system outcomes. Simple spider diagrams illustrate how some food system outcomes may improve under future scenarios, while others will remain the same or even decrease. For example, under an adaptive diverse governance scenario in the Caribbean, regional stakeholders identified increases in production, within region trade and social and cultural values, but decreases in trade outside the region and in affordability. Using the same scenarios, stakeholders also identified which global environmental change concerns would increase or decrease in the future (Figure 2).

The challenges of ensuring food security whilst avoiding negative social and environmental feedbacks require an integrated research effort, with contributions from many disciplines. It also requires understandings and insights from local, regional and global studies. Finally, it requires tools such as scenarios to bridge the gaps between the scientific research and the policy making communities, so that research insights are brought to bear on decision and policy making processes. The GECAFS project invites the community of food security and earth systems researchers to join us in this endeavour.

Polly Ericksen
Environmental Change Institute, Oxford University Centre for the Environment South Parks Road, Oxford, OX1 3QY UNITED KINGDOM
email: envc0082@herald.ox.ac.uk

References

1. Ericksen, P. J. 2008. Conceptualizing Food Systems for Global Environmental Change (GEC) Research. *Global Environmental Change* Vol 18 (1):234-245.
2. World Resources Institute. EarthTrends http://earthtrends.wri.org/
3. Food and Agriculture Organization Statistics Division.
4. GECAFS (2006) A Set of Prototype Caribbean Scenarios for Research on Global Environmental Change and Regional Food Systems. GECAFS Report No. 2; 62pp, Wallingford.
5. Molden, D., and C. d. Fraiture. 2004. Investing in water for food, ecosystems and livelihoods: Blue Paper, Stockholm 2004: Comprehensive Assessment of Water Management in Agriculture.
6. Pretty, J. N., A. S. Ball, T. Lang, and J. I. L. Morison. 2005. Farm costs and food miles: An assessment of the full cost of the UK weekly food basket. *Food Policy* 30:1-19.
7. Matson, P. A., W. J. Parton, A. G. Power, and M. J. Swift. 1997. Agricultural Intensification and Ecosystem Properties. *Science* 277:504-509.
8. Geist, H., E. Lambin, W. McConnell, and A. D. 2005. Causes, Trajectories and Syndromes of Land-use/Cover Change. *IHDP Newsletter*, 2005.
9. Wood, S., S. Ehui, J. Alder, S. Benin, K. G. Kassman, H. D. Cooper, T. Johns, J. Gaskell, R. Grainger, S. Kadungure, J. Otte, A. Rola, R. Watson, U. Wijkstrom, and C. Devendra. 2005. Chapter 8 - Food. In *Ecosystems and Human Well-being: Current State and Trends*. Washington, D.C.: Island Press.
10. DeFries, R. S., G. P. Asner, and R. Houghton. 2005. Trade-offs in Land-use decisions: towards a framework for assessing multiple ecosystem responses to land use change. In *Ecosystems and Land use change*, eds. R. S. DeFries, G. P. Asner and R. Houghton. Washington, DC: American Geophysical Union.
11. Fischer, G., M. Shah, and H. v. Velthuizen. 2002. Climate change and agricultural vulnerability. Vienna: International Institute for Applied Systems Analysis (IIASA).

Earth Systems Modelling: New Insights into the Future of Water, Land and their Interactions

J. Alcamo, M. Floerke, R. Schaldach, M. Weiss

Earth systems modelling is a very modern approach for studying the complexity of the world, and its first usage has already brought new understanding about how the atmosphere and climate functions. Now this approach is also aiding science to better understand the functioning of processes literally "on the ground", that is, in the global land and freshwater systems. Novel modelling methods and simulations are yielding new insight into long term, large scale changes in water use, water availability and land cover. At the same time, scientists are getting better at representing society as an agent of change in these models. New approaches have yielded new insights, as we describe here.

Changes in the Global Water System

Since the mid-1990s a small set of global models have been developed with the capability of simulating important aspects of the global water system. One such model is WaterGAP (*W*ater - Global *A*ssessment and *P*rognosis), which simulates large-scale, long-term changes in water resources on a global grid. WaterGAP is made-up of two main submodels: one that computes global hydrology and various water availability indicators, and another that calculates global water use in different sectors (households, manufacturing, electricity production, irrigation and livestock) [1, 2]. Information from these submodels is used to estimate changes in global water stress as affected by changes in climate and socio-economic factors.

Although WaterGAP and similar models cover only a part of the complexity of the global water system, their results are beginning to paint a consistent picture of changes in the system expected over the coming decades. For example, scenario studies consistently find an increasing trend in water stress over a large percentage of the world's river basins. One recent study with WaterGAP computed that 62 to 76% of the world's river basin area may experience an increase in water stress up to 2050, under a wide range of scenario assumptions [3]. Most of these river basins are in the developing world where the chief cause of growing water stress is likely to be a sharp increase in water withdrawals, with climate change playing an important but secondary role.

Not only do withdrawals grow in developing countries under most scenarios, but a significant structural change in their profile of water use is also observed. This is particularly pronounced in tropical developing countries where irrigation is now the dominant water use. For example, the domestic and other non-agriculture water sectors currently account for only a few percent of total withdrawals in Africa, but their share grows to over 40% by 2050 according to a recent scenario analysis (Figure 1) [4]. Structural change in the water sector is likely to have an important effect on both the future state of the freshwater system and on water policies. The expected huge growth in domestic and manufacturing

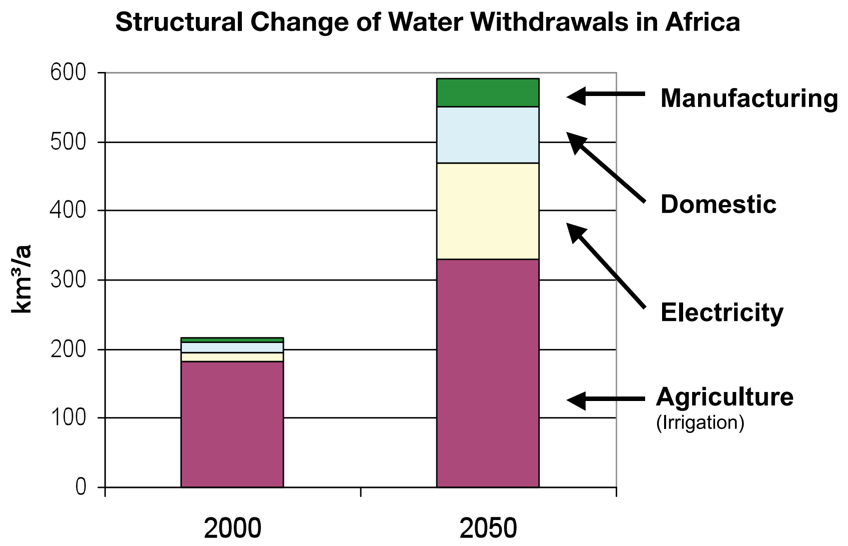


Figure 1. Structural change in water use sectors in Africa between 2000 and 2050. This is an updated version of the Security First scenario of GEO-4 (Global Environmental Outlook) of the United Nations Environment Programme. The updated scenario differs from the original version in that new irrigation withdrawals were computed by the WaterGAP model based on new agricultural land simulations from the LandSHIFT model.

water use implies a similarly large increase in the discharge of wastewater to freshwater systems and a probable degradation of aquatic ecosystems, that is, unless wastewater treatment becomes common practice. These simulations also imply an enormous demand for new water infrastructure in the region.

Large Scale Changes in Land Use

As new global water models have been used to investigate changes in the global water system, new global land use models are coming online for investigating the consequences of development on continental and global land resources. One example is the LandSHIFT model (*Land Simulation to Harmonize and Integrate Freshwater availability* and the *Terrestrial environment*) which computes changing land use/cover on a global grid using a modified cellular automata approach [5, 6]. The basic idea of the model is to allocate land use requirements for crop and livestock production and settlement area in a consistent, systematic way. The model distinguishes between 14 land use types and 17 crop sub-types.

LandSHIFT was recently used to estimate future land use/cover changes in Africa under the GEO-4 (Global Environmental Outlook) scenarios of the United Nations Environment Programme. Figure 2 shows computed land use/cover changes up to 2050 for the *Security First* scenario. Under this scenario, population grows in Africa from 800 to 2,270 million and average income roughly doubles between 2000 and 2050. These changes lead to large increases in country-scale crop and livestock production [7]. Under the *Security First* scenario, countries give higher priority to national food independence than international food trade, which means that crops are not necessarily grown where they grow best. Hence agricultural yields are not as large as in other scenarios and more land is needed to produce a given ton of crops. Between 2000 and 2050, cropland area increases by two-thirds and grazing area by about 60%. Although urban areas cover a relatively small fraction of total area, they grow by a factor of 2.6. The expansion of agricultural land comes mainly at the expense of forested land, which declines by slightly over a million km², and other unmanaged "natural" land (mostly shrub land and savanna), which shrinks by about 5 million km². A key question for policy is whether the ecosystem services gained by opening up new cropland and grazing land offsets the possible losses in ecosystem services from former forest and other natural land (e.g. lumber production, medicines, genetic resources, water conservation, carbon retention).

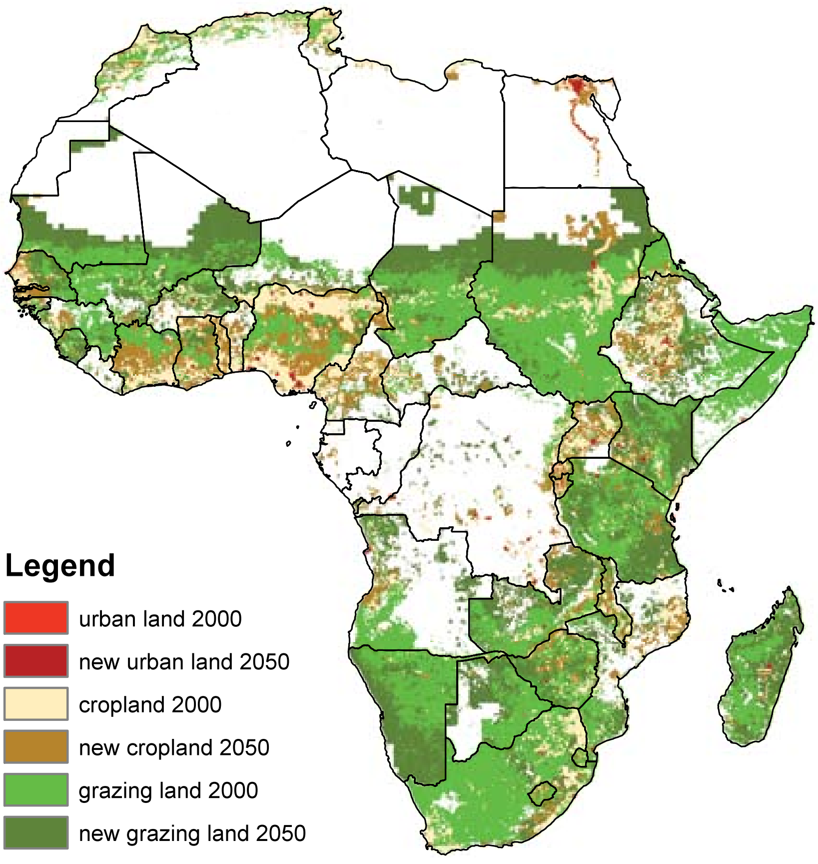


Figure 2. Changes in land use/cover in Africa between 2000 and 2050, simulated with the LandSHIFT model for the updated version of the *Security First* scenario of GEO-4 (Global Environmental Outlook) of the United Nations Environment Programme.

Water and Land Interacting

New developments in global water and land modeling have also made it possible to better quantify the important interactions between water and land on the continental and global scale. Understanding these interactions is relevant to policy making because it provides new information about the adequacy of water resources for future food production, and conversely, about the impact of expanding agriculture on regional water availability.

In a recent model experiment, WaterGAP and LandSHIFT

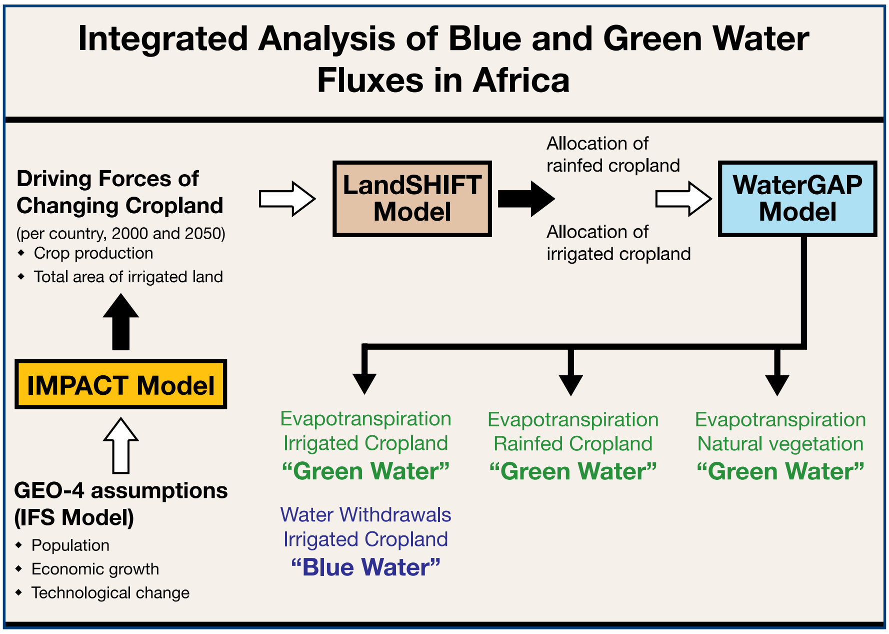


Figure 3. Set of global models used for integrated analysis of blue and green water fluxes in Africa.

computations were combined with a third model, "IMPACT" [7] (Figure 3), to quantify the relationship between land use/cover in Africa and the continental-scale water balance. WaterGAP is used here to compute the flux of water evaporated and transpired from cropland ("green" water fluxes) versus the amount of water abstracted from water systems for irrigation ("blue" water fluxes). Comparing these two metrics gives an idea of the relative importance of water requirements for rainfed versus irrigated agriculture in Africa.

For the year 2000, evapotranspiration from Africa's rain-fed cropland (green water flux) is computed to be about 1,080 km^3/year, while the abstraction of surface water and groundwater for irrigation (blue water flux) is approximately 180 km^3/year. By 2050, under the assumptions of the GEO-4 *Security First* scenario, evapotranspiration from rain-fed cropland increases to about 2,040 km^3/year and irrigation abstraction to 330 km^3/year. Hence the water transpired or evaporated annually from Africa's rain-fed cropland (green water) is about six times greater than the volume of water used in liquid form to irrigate crops (blue water). These findings suggest that it is very worthwhile to try and reduce the amount of water evaporated or transpired from cropland (or conversely to increase the "water productivity" of cropland).

Of course, these and other findings from earth systems modeling cannot replace research and policy making at the local to national scale. Nevertheless, they can provide fresh insights into changes to water and land resources that can be easily overlooked unless the viewer takes an earth systems view.

Joseph Alcamo
email: alcamo@usf.uni-kassel.de

Martina Floerke
email: floerke@usf.uni-kassel.de

Ruediger Schaldach
email: schaldach@usf.uni-kassel.de

Martina Weiss
email: weiss@usf.uni-kassel.de

Center for Environmental Systems Research, University of Kassel, GERMANY

References

1. Alcamo, J., Döll, P., Henrichs, T. Kaspar, F., Lehner, B., Rösch, T., Siebert, S. 2003a. Development and testing of the WaterGAP 2 global model of water use and availability. *Hydrological Sciences*. 48(3):317-337.
2. Döll, P., Kaspar, F., and Lehner, B.: 2003, A global hydrological model for deriving water availability indicators: model tuning and validation, *Journal of Hydrology* 270, 105-134.
3. lcamo, J., Floerke, M. Maerker, M. 2007. Future long-term changes in global water resources driven by socio-economic and climatic changes. *Hydrological Sciences*. 52(2): 247-275.
4. Rothman, D., Agard, J., Alcamo, J. 2007. Chapter 9: The Future Today. In: UNEP (United Nations Environment Programme). Global Environmental Outlook - Number 4 (GEO-4). Earth Print Limited, P.O. Box 119, Stevenage, Hertfordshire SG14TP, U.K.
5. Schaldach, R., Priess, J., Alcamo, J. 2008. Simulating the impact of biofuel development on country-wide land-use changes in India. Journal of *Biomass and Bioenergy*. Submitted.
6. Alcamo, J., Schaldach, R. 2006. LandShift: Global modeling to assess land use change. In: Tochtermann, K., Scharl, A. Proceedings of EnviroInfo - 2006. 20th International Conference on Informatics for Environmental Protection. Graz, Austria. Springer:Berlin.
7. As part of the GEO-4 scenario analysis, country-scale crop and livestock productions were computed by the "IMPACT" model (*International Model for Policy Analysis of Agricultural Commodities and Trade*) of the International Institute of Food Policy Research. Assumptions from the GEO-4 study were used to drive the model. Production on the country-scale was then spatially allocated by the LandSHIFT model.

Establishing High Altitude Climate Observatory Systems in the Ethiopian Highlands

S. Grab, G. Zeleke, C. Drexler

During the past century, Africa's two highest mountains–Mount Kilimanjaro and Mount Kenya–have respectively lost 82% and 92% of their ice cover. The changing state of African mountains was brought into focus by last year's Intergovernmental Panel on Climate Change 4th Assessment Report, which stated that Africa's mountain ecosystems "appear to be undergoing significant observed changes, aspects of which are likely to be linked to complex climate-land interactions and which may continue under climate change."

In Africa, long-term (several decades) high mountain climate monitoring has been absent, making it difficult to quantify the precise rate and extent of climate change, as well as provide data for high-resolution climate models and long-term forecasts for specific mountain regions of Africa.

Yet, given the importance of subsistence agriculture in many African mountains and highlands, it is critical that accurate forecasts are made to develop appropriate agricultural and land-use adjustments and disaster risk reduction programmes.

African mountains play an important role in balancing the continent's ecosystems and could hold important clues to Africa's past climate changes. Many African mountain environments are surrounded by drought-prone and low-rainfall regions; because the mountains have a positive water balance, they are able to act as water reservoirs to surrounding regions. African mountains also offer important refuge to human habitation, fauna and flora. It is thus essential to quantify and understand what contribution climate, as a global change driver, is making towards changing biological, agricultural, tourism and other mountain environmental and socio-economic systems.

To that end, the Mountain Research Initiative (MRI), a collaborative research programme on global change and mountain regions, launched the Global Change Research Network for African Mountains (GCRN_AM) in 2007. Phase I of the programme is focussing on establishing climate observatory systems in the Ethiopian highlands.

Background and motivation

Understanding high altitude climate variability / change in Ethiopia is now urgent for a variety of important reasons, including:

- High altitude precipitation and associated hydrological changes directly impact the regional and international (Sudan and Egypt) hydrology. Several of the Ethiopian Rift Valley lakes are rapidly drying; a better knowledge of the high altitude hydrology will contribute to understanding the various mechanisms responsible for changes at lower altitudes;
- The spread of climate-related health risks, particularly those related to climate warming at high altitudes (e.g. malaria), needs to be understood and planned for;
- The suitability of commercial and subsistence crops (e.g. tea, coffee, sorghum etc) grown in mountain regions is likely to shift altitudinally as climate changes; agricultural planning in Ethiopia thus requires regional climate data from lower to higher altitudes;
- Planning is needed for climate-related disaster risk reduction initiatives (e.g. drought, floods, landslides, etc.) at high altitudes (where the human population continues to grow);
- High altitudes in Ethiopia host a variety of endemic flora and fauna, many of which are classified by the IUCN as endangered or critically endangered (e.g. Wallia Ibex, Ethiopian Wolf); understanding climate impacts on high altitude ecosystems and establishing associated sustainable development and conservation mechanisms requires climate data from high altitudes.

Although a network of meteorological stations exists throughout Ethiopia, including the highlands, there is a general absence of permanent stations above 3000 meters. The new initiative by GCRN_AM has proposed to establish high altitude climate observatories on at least six mountain summits in the Ethiopian highlands. These observatories will provide data for climate modelling, generate local / regional scientific knowledge which can be fed into local/regional/international scientific agendas, help predict and plan for impacts on ecosystems, economies etc., provide data for modelling water budgets, and provide educational data for tertiary and secondary educational sectors.

A concept proposal, available on MRI's website (http://mri.scnatweb.ch/dmdocuments/Concept_Proposal_African_MtnObservatories.pdf), outlines objectives and outputs, types of stations, ownership, local stakeholder benefits, and training and support required. For further information on the Ethiopian mountain research initiatives and programs, please contact Dr Gete Zeleke: G.Zeleke@cgiar.org.

To get involved in the Global Change Research Network in African Mountains please contact:

Dr. Bob Nakileza
Mountain Resource Centre,
Makerere University,
Kampala, UGANDA
email: nakilezab@yahoo.com

Claudia Drexler
Communication and Event Management,
The Mountain Research Initiative, SWITZERLAND
email: drexler@giub.unibe.ch

GCRN_AM website:
http://mri.scnatweb.ch/content/category/3/61/80/

Stefan Grab
School of Geography, Arch. & Enviro. Studies
University of Witwatersrand, SOUTH AFRICA
email: stefan.grab@wits.ac.za

Gete Zeleke
Global Mountain Program, CGIAR, Addis Ababa, ETHIOPIA
email: g.zeleke@cgiar.org

Claudia Drexler
The Mountain Research Initiative
Bern, SWITZERLAND
email: drexler@giub.unibe.ch

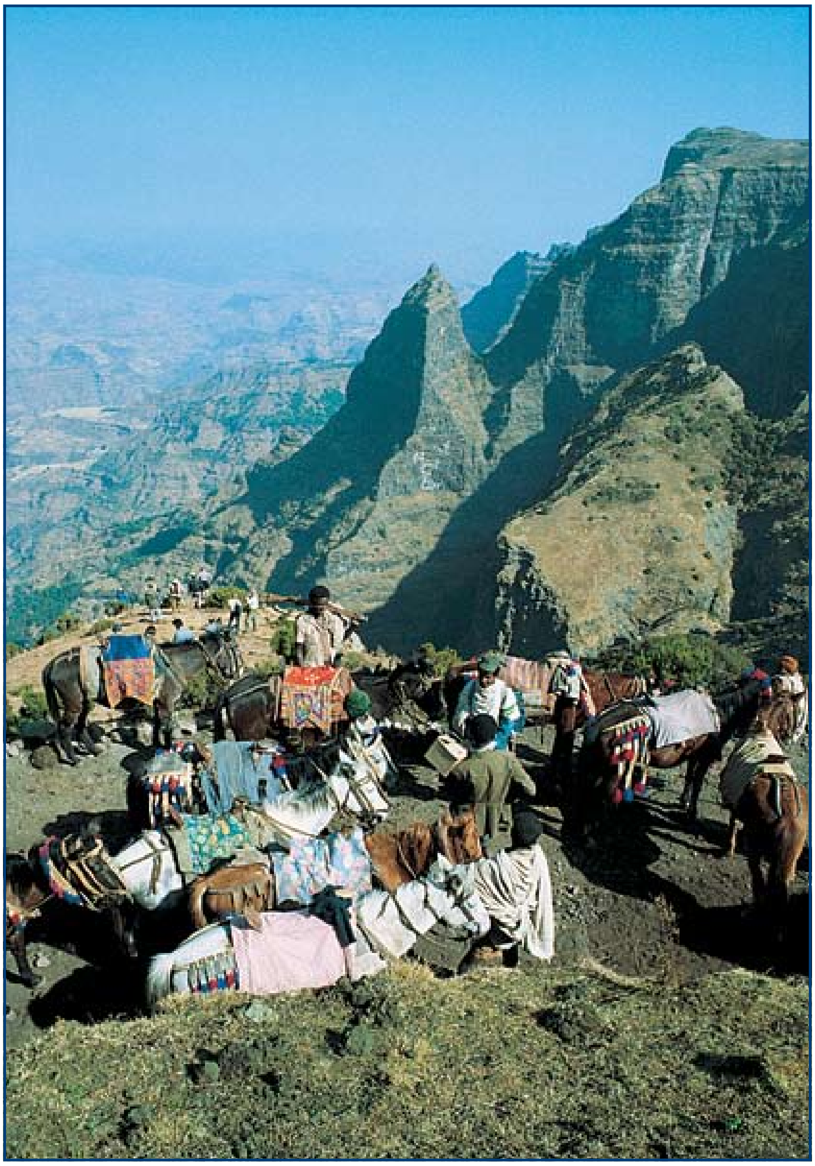


Figure 1.Trekking to the Simien Mountains National Park, the highest mountain system in the Horn of Africa and an excellent site for scientific observations of global change in mountain areas. Hans Hurni, CDE, University of Bern.

Proposed High Altitude Observatories in Ethiopia:

- Gulele
- Simien (at 3500m; 4400m – Buwhit)
- Mugalat (3100m; representing the dry NE)
- Choke (2800m; 3300m; 4200m)
- Tulu Welel (3200m, forested area in the west)
- Muleta (3361, degraded area in the east)
- Guge (4200m, important Rift Valley catchment, west)
- Bale (3400m, 4300m, important catchment for southern Ethiopia)

IGBP and Related Global Change Meetings

A more extensive meetings list is available on the IGBP web site at www.igbp.net.

July

15th International Conference on Clouds and Precipitation

7-11 July, Cancun, Mexico

http://convention-center.net/iccp2008/

SCAR/IASC Open Science Conference

8-11 July, St. Petersburg, Russian Federation

http://www.scar.org/events/#2008

Coping with Global Change in Marine Social-ecological Systems

8-11 July, Rome, Italy

http://www.peopleandfish.org
Contact: Ian Perry (PerryI@pac.dfo-mpo.gc.ca)

4th International Limnogeology Congress

11-14 July, Barcelona, Spain

http://www.ilic2007.com/

37th Scientific Assembly of the Committee on Space Research and Associated Events-COSPAR 2008: "50th Anniversary Assembly"

13-20 July, Montreal, Canada

http://www.cospar2008.org

Ocean Carbon and Biogeochemistry (OCB) Summer Workshop

21-28 July, WHOI, MA, United States

http://www.whoi.edu/sites/ocbworkshop2007

4th International Conference on Environmental Science and Technology 2008

28-31 July, Houston, TX, United States

http://www.aasci.org/conference/env/2008/index.html

August

33rd International Geological Congress: Earth System Science: Foundation for Sustainable Development

05-14 August, Oslo, Norway

http://www.pages.unibe.ch/calendar/calendar08.html

31st International Geographical Congress

12-15 August, Tunis, Tunisia

http://www.homeofgeography.org
Contact: General Secretary (Ali.Toumi@fshst.rnu.tn)

World Water Week in Stockholm

17-23 August, Stockholm, Sweden

http://www.worldwaterweek.org/

September

13th World Water Congress

01-04 September, Montpellier, France

http://www.worldwatercongress2008.org

3rd International Conference on Climate and Water

03-06 September, Helsinki, Finland

http://www.ymparisto.fi/default.asp?contentid=169172&lan=en

Human Dimensions in Fisheries and Wildlife Management

5-9 September, Colorado, United States

http://www.warnercnr.colostate.edu/nrrt/hdfw

October

International Scientific Conference on Tropical Rainforests and Agroforests under Global Change

05-09 October, Bali, Indonesia

http://www.globalchange-2008.org

SCOR/IOC/IGBP/IAEA Symposium on the Ocean in a High CO2 World

6-8 October, Monaco

Contact: Ed Urban (Ed.Urban@scor-int.org)

6th International Human Dimensions Workshop

12-15 October, New Delhi, India

Contact: Maarit Thiem (thiem.ihdp@uni-bonn.de)

7th IHDP Open Meeting 2008: Social Challenges of Global Change

16-19 October, New Delhi, India

http://www.ihdp.org

November

1st IMBER IMBIZO: Biogeochemical and Ecosystems Interactions in a Changing Ocean

09-13 November, Miami, FL, United States

http://www.imber.info/imbizo.html

World Conference on Marine Biodiversity

11-15 November, Valencia, Spain

http://www.marbef.org/worldconference/

4th EGU Humboldt Conference on "The Andes: Challenge for Geosciences"

24-28 November, Santiago de Chile, Chile

http://www.egu.eu/info/alexander_...dt_international_conferences.html

Pin Board

Note: Correspondence

The Pin Board is a place for short announcements and letters to the editor. Announcements may range from major field campaigns, new websites, research centres, collaborative programmes, policy initiatives or political decisions of relevance to global change. Letters to the editor should not exceed 200 words and should be accompanied by name and contact details.

Prof. Chris Rapley awarded for his work on climate change

Professor Chris Rapley, former Executive Director of IGBP (1994-1997), was awarded the 2008 Edinburgh Medal for his work on climate change. The prestigious award, made as part of the Edinburgh International Science Festival, is presented each year to men and women of science and technology whose professional achievements are judged to have made a significant contribution to the understanding and wellbeing of humanity.

Review of IGBP: Input sought by 15 May 2008

A review of IGBP is being conducted by ICSU, the programme's sponsor, in collaboration with the International Group of Funding Agencies for Global Change Research. The review centers on the overarching question of "what do scientists, sponsors, and end-users get out of participating in and supporting the international programme that they would not have gained if it did not exist?" The Review Panel invites input at igbp.review@icsu.org. Alternatively, you can complete a web-based questionnaire at http://www.surveymonkey.com/s.aspx?sm=KCbwuTkR_2biaGko2fOCtp5w_3d_3d

Comments will be particularly useful if received by 15 May. Further details of the review can be found at http://www.icsu.org/5_abouticsu/STRUCT_Comm_Adhoc_IGBP-WCRP.html.

IGBP Projects Launch New Websites

The Surface Ocean-Lower Atmosphere Study (SOLAS) and the Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS) have recently redesigned their websites.

The SOLAS website (http://www.uea.ac.uk/env/solas/) features a new visual profile, an enhanced navigation structure, and aims to promote interaction between scientists by allowing scientists to publish news items reaching a very wide audience and hence give publicity to their projects.

iLEAPS has launched a new website (http://www.ileaps.org/) based on Joomla, an open source content management system. Among other things, the new site features the new ESSP visual profile, an enhanced navigation structure, and offers multisites for two iLEAPS projects.

Global Change Science Poster Competition

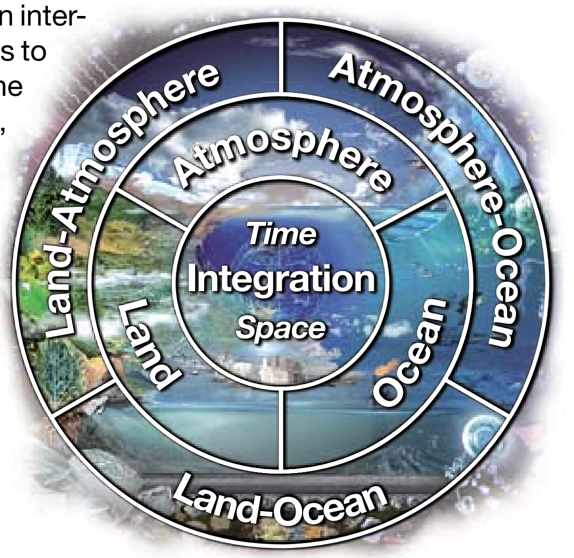
In November 2007 the Russian National Committee of IGBP organised a global change science poster competition with the goal of popularising global change science. The competition was open to Russian students and young scientists, and participants were asked to write for a general audience and to utilise online resources such as the IGBP and IPCC websites in preparing their contributions. The winners have now been selected, and their posters can be downloaded from the IGBP website (http://www.igbp.net/page.php?pid=402). First prize went to Anastasiya Revokatova whose poster focussed on the role of anthropogenic and natural factors in climate changes.

New Report Published

The Global Carbon Project has published the report "Carbon Reductions and Offsets" with a number of recommendations for individuals and institutions who want to participate in this voluntary market. The report explores the issues surrounding voluntary reductions in carbon emissions through efficiencies and emission avoidance and the selection of appropriate carbon offsets where needed. It includes a framework for decision making that focuses on the Earth System Science Partnership (ESSP) and its programs and projects, where travel, conferences and office support are the major emission causing activities. However, the findings apply to most international projects and research institutions conducting a variety of field, laboratory and administrative activities with significant carbon footprints.

The International Geosphere-Biosphere Programme

IGBP is an international scientific research programme built on interdisciplinarity, networking and integration. The vision of IGBP is to provide scientific knowledge to improve the sustainability of the living Earth. IGBP studies the interactions between biological, chemical and physical processes and human systems, and collaborates with other programmes to develop and impart the understanding necessary to respond to global change. IGBP research is organised around the compartments of the Earth System, the interfaces between these compartments, and integration across these compartments and through time.



IGBP helps to

- develop common international frameworks for collaborative research based on agreed agendas
- form research networks to tackle focused scientific questions and promote standard methods
- guide and facilitate construction of global databases
- undertake model inter-comparisons
- facilitate efficient resource allocation
- undertake analysis, synthesis and integration of broad Earth System themes

IGBP produces

- data, models, research tools
- refereed scientific literature, often as special journal editions, books, or overview and synthesis papers

- syntheses of new understanding on Earth System Science and global sustainability
- policy-relevant information in easily accessible formats

Earth System Science

IGBP works in close collaboration with the International Human Dimensions Programme on Global Environmental Change (IHDP), the World Climate Research Programme (WCRP), and DIVERSITAS, an international programme of biodiversity science. These four international programmes have formed the Earth System Science Partnership (ESSP). The International Council for Science (ICSU) is the common scientific sponsor of the four international global change programmes.

Participate

IGBP welcomes participation in its activities – especially programme or project open meetings (see meetings list on website). To find out more about IGBP and its research networks and integration activities, or to become involved, visit our website (www.igbp.net) or those of our projects, or contact an International Project Office or one of our 74 National Committees.

Contributions

The Global Change NewsLetter primarily publishes articles reporting science undertaken within the extensive IGBP network. However, articles reporting interesting and relevant science undertaken outside the network may also be published. **Science Features** should balance solid scientific content with appeal to a broad global change research and policy readership. **Discussion Forum** articles should stimulate debate and so may be more provocative. Articles should be between 800 and 1500 words in length, and be accompanied by two or three figures or photographs. Articles submitted for publication are reviewed before acceptance for publication. Items for the **Pin Board** may include letters to the editor, short announcements such as new relevant web sites or collaborative ventures, and meeting or field campaign reports. Pin Board items should not exceed 250 words.

Photographs should be provided as TIFF or high resolution JPG files; minimum of 300 dpi. Other images (graphs, diagrams, maps and logos) should be provided as vector-based EPS files to allow editorial improvements at the IGBP Secretariat. All figures should be original and unpublished, or be accompanied by written permission for re-use from the original publishers.

The Global Change NewsLetter is published quarterly. The deadline for contributions is two weeks before the start of the month of publication. Contributions should be emailed to the editor.

ICSU International Council for Science

ISSN 0284-5865

Publication Details

Circulation: 10,000 copies
Published by:

IGBP Secretariat
Box 50005
SE-104 05, Stockholm
SWEDEN

Editor-in-chief: Kevin Noone (zippy@igbp.kva.se)
Editor: Mary Ann Williams (maryann@igbp.kva.se)
Graphic designer: Hilarie Cutler (hilarie@igbp.kva.se)

The current and past issues of the Global Change NewsLetter are available for download from www.igbp.net. Requests for reproduction of articles appearing in the NewsLetter should be emailed to the editor. Changes to address information for receipt of the NewsLetter should be emailed to charlottew@igbp.kva.se.